

REMARKS

The Examiner's Action was issued following the filing of a Brief on Appeal on June 16, 2004.

Claims 1 – 11 are pending in this application.

Claim Rejections - 35 USC § 103

The Examiner rejected claims 1 – 11 as being unpatentable over Davitt et al. (4,419,154) in view of Taylor et al. (3,291,664).

Reconsideration of this rejection is requested for the following reasons.

The Present Invention

The claimed invention is directed to delay compositions for use in delay detonators or other detonation delay devices employed in blasting operations, e.g., mining or quarrying, to create a delay between a firing signal (onset of ignition) and the instant at which an explosive charge is set off, and thereby to provide desired control of the timing sequence of detonation of charges (p. 1, lines 4-24).

More particularly, the invention defined by claim 1 is a delay composition *per se*, comprising mixed particles of silicon, barium sulfate and red lead, the red lead being present in an amount of about 3 to 15% by weight of the composition (p. 5, lines 24-27). Preferably, the red lead is present in an amount of about 6 to 12% (claim 2; p. 5, line 26), and more preferably in an amount of about 9 to 12% (claim 3; p. 5, lines 26-27), by weight of the composition.

The composition may contain about 40 to 60% by weight of barium sulfate and about 25 to 50% by weight of silicon (claim 4; p. 5, lines 28-30). In addition, the composition preferably also contains a binder causing collections of the particles to bind together in the form of free-flowing granules (claim 5; p. 6, lines 1-2). Suitable binders include solvent-soluble polymers, silica and swelling clays (claim 6; p. 6, lines 3-4), preferably a water-soluble derivative of cellulose (claim 7; p. 6, lines 4-5), e.g. carboxymethyl cellulose (claim 8; p. 6, line 5). Also preferably, the binder is present in an amount of 0.2 to 0.6% by weight of the composition (claim 9; p. 6, lines 2-3).

While all the claims, as stated, are directed to delay compositions *per se*, these compositions afford particularly important advantages when used in delay elements having rigid metal confinement elements, as distinguished from lead confinement elements. The term "rigid metal," in Applicant's specification, refers to metals (such as zinc, aluminum, steel and brass) that, when used to form confinement elements, are not easily drawn to a desired diameter or shaped using equipment conventionally used for lead, which is a soft metal. Heretofore, lead has commonly been employed to form confinement elements, but for environmental and other reasons it is currently preferred to use rigid metal in at least many instances. Owing, however, to the fact that these rigid metals have higher thermal conductivities and heat capacities than lead, they extract more heat from the column of delay composition as it burns, which can increase the failure rate of detonators and delay devices because there may be insufficient heat remaining in the delay composition until complete consumption of the composition has taken place, especially in low temperature environments of use and in delay units intended to provide long delays (p.2, line 18 - p. 3, line 12).

In the compositions of the claimed invention, the properties achieved by the presence of about 3 to 15 wt.% of red lead afford special advantages for use with a rigid metal confinement element. Pertinent test results are set forth in Table 1 (p. 12, lines 1-11) and in Figs. 9 and 10. Table 1 shows that at contents from 3% up to 9%, red lead increases the average time of delay compared to a composition having 0% red lead (hence, red lead is not acting just as an accelerant to the combustion process as might be expected); at the same time, a considerable improvement in reliability (Coefficient of Variation) is achieved compared to the composition having no red lead. Figs. 9 and 10 show that, over the range of 3 - 15% for red lead, the delay timings and the Coefficient of Variation (CV) remain quite stable (reach a plateau), which are essential considerations for the present invention. If these values varied significantly within the range, it would make the compositions very sensitive to content variations, and it would be necessary to measure the proportions of the ingredients very precisely, possibly more precisely than is compatible with mass-production. Figs. 9 and 10 also show that the delay timing and CV are optimal for the invention.

More generally, Example 1 (p. 11, line 13 - p. 12, line 25) demonstrates that the addition of a small amount of red lead to a barium sulfate/silicon mixture results in a composition exhibiting "improved performance in rigid [metal confinement] elements." That is to say, the presence of red lead in the claimed amount (3-15%), while not substantially

altering the burning rate of a barium sulfate/silicon mixture, imparts resistance to quenching caused by the heat-sink effect of a rigid metal confinement element (p. 10, lines 23-28).

It can therefore be stated that the present invention is concerned with achieving resistance to quenching of barium sulfate/Si type delay compositions when used in a rigid metal confinement element without substantially affecting burning rates.

Davitt et al.

Davitt et al. is concerned with the production of a pyrotechnic delay composition of intermediate to slow burning time intended for use with confinement elements made of lead (Col. 2, lines 65 to 66; and Col. 6, line 38). The basic composition consists of 45 to 70% by weight of barium sulfate and 30 to 55% by weight of silicon (Col. 2, lines 7 to 11). This provides a composition that contains no recognized carcinogens or any water-soluble material (Col. 2, lines 1 to 4). Davitt et al. reported that the disclosed delay compositions may in some cases advantageously contain a proportion of red lead oxide (Col. 5, final two lines to Col. 6, line 1). Davitt et al. stated that:

“The inclusion of red lead oxide has the effect of somewhat speeding up the burning time of the composition without any adverse effect on either toxicity or water solubility. Typically, such a three-component composition comprises from 15 to 60% by weight of barium sulphate, from 25 to 75% by weight of red lead oxide and from 5 to 40% by weight of silicon.” (Col. 6, lines 1 to 8).

The addition of red lead was therefore made in order to speed up (i.e. reduce) burning times, thereby creating a faster-burning delay composition.

Examples 13-19 of Davitt et al. tested compositions containing from 52.4% to 36.1% (maintaining a constant ratio of barium sulfate to red lead) and from 5.7 to 35% Si. The results showed that mean delay times generally decreased as the amount of Si increased and the amount of oxidants (barium sulfate and red lead combined) decreased. It is difficult to determine from these Examples what effect red lead itself had on the delay times.

Examples 20 to 27 of Davitt et al. tested the effect of variations of the ratio of barium sulfate to red lead and concluded: *“any increase in the proportion of barium sulphate (at the expense of red lead oxide) has the effect of retarding the delay time of the composition.”* Thereby indicating that higher proportions of red lead increase the rate of burning.

Example 28 of Davitt et al. assessed the effect of specific surface area of Si on the mean delay time and concluded that: *“the mean delay time decreases as silicon specific surface area is increased”*.

Examples 29 and 30 of Davitt et al. test the relationship between delay time and delay element length and, not surprisingly, conclude that there is a linear relationship between delay time and element length.

Examples 31 and 32 of Davitt et al. assess the low temperature timing performance and reliability of the three-component compositions by testing them at -45°C. Using compositions containing amounts of red lead of 64.1% and 51.8%, no failures occurred at the low firing temperatures.

Example 33 of Davitt et al. showed that a particular composition (containing 64.1% red lead) was suitable for use with electric detonators.

In the Examples that relate to the three-component mixture, the percentage of red lead varied from 36.1% (Example 19) to 74.1% (Example 27) by weight of red lead.

In summary, Davitt et al. teaches that compositions of barium sulfate and silicon make effective delay compositions for use with lead confinement elements, and that the addition of red lead in amounts of 25 to 75% by weight increase burning rates (decrease burning times) without affecting low temperature reliability and performance, as well as toxicity and water solubility. Greater amounts of red lead in this range increase the burn rates, but burn rate adjustments can be made by varying the specific surface area of the silicon (delay time decreases as Si surface area increases).

What Davitt et al. does not teach is what effect the use of red lead in an amount of less than 25% by weight (but above 0%) would have on the characteristics of the composition, e.g. burning times, performance or reliability, especially when using rigid metal confinement elements. Since the objective of adding red lead to the two-component composition is evidently to increase burn rates (decrease burn times), presumably this advantage only manifests itself at amounts of 25% or more. It should be kept in mind that the inventors of the present invention found that, at contents from 3% up to 9%, red lead increases the average time of delay compared to a composition having 0% red lead (Table 1 of the present application).

Examiner's Rejection

Regarding Davitt et al., the Examiner stated:

"Davitt et al discloses a delay composition comprising 15-60% barium sulfate, 25-75% red lead and 5-40% of silicon. Davitt further states that the inclusion of red lead speeds up the burning time of the composition."

The Examiner then went on to say:

"It would have been obvious to one having ordinary skill in the art at the time the invention was made to use less red lead to result in a lower burning rate. Since Davitt teaches that the inclusion of red lead would speed up the burning rate, it would conversely decrease if less red lead were used."

This conclusion may be true (at least within the range of 25-75% red lead), but it is not relevant to the present invention. Davitt et al. does not disclose any information or statements that red lead in an amount of 3-15% by weight (as required in the present invention) improves the reliability of compositions, especially when used in rigid confinement elements. The only compounds tested for reliability by Davitt et al. had amounts of red lead of 64.1 and 51.8% (Examples 31 and 32), which would suggest that amounts of red lead much higher than 15% are required for reliability.

If a person of ordinary skill in the art reviewed Davitt et al., there would be no motivation to decrease the amount of red lead below 25% by weight. Red lead is used by Davitt et al. to increase the burn rate, so there would be no reason to use less than the minimum stated by Davitt et al. From the Examiner's comments, it seems that the Examiner believes that the objective of the present invention is to reduce the burn rate, and that this would be obvious from Davitt et al. by using an amount of red lead below 25%, but the present invention has nothing to do with modifying the burn rate. Instead it has the objective of improving reliability of combustion (especially when used in rigid confinement elements) and, if anything, Davitt et al. teaches away from the concept of using small amounts of red lead to improve reliability because the tests for reliability carried out by Davitt et al. employed compositions having large amounts of red lead (Examples 31 and 32). If it is understood that red lead is a powerful oxidant, it would be logical to assume that it should be used in large amounts in compositions to improve reliability of combustion (by providing more oxidant for the Si fuel). The opposite, i.e. using small amounts, would be counterintuitive.

If the skilled artisan were motivated to optimize the amount of red lead based on the disclosure of Davitt et al., such optimization would be within the range provided by Davitt et al., i.e. 25-75% by weight. There would be no reason to optimize amounts outside this range as the effects of such amounts are not discussed by Davitt et al.

It is therefore believed that the present invention is neither disclosed in, nor obvious from, Davitt et al. considered alone.

Taylor et al.

The broadest of the rejected claims are directed to a delay composition comprising mixed particles of silicon, barium sulfate and red lead (in the required amount), although the claims are being examined with respect to an elected species also including a binder (carboxymethyl cellulose). The claims were therefore rejected as unpatentable over Davitt et al. in view of Taylor et al. The Examiner asserts that Davitt et al. discloses a delay element that comprises barium sulfate, silicon and red lead (which assertion has been addressed above); that Taylor et al. discloses the use of carboxymethyl cellulose with a delay composition; and that it would have been obvious to use the binder of Taylor et al. with the delay composition of Davitt et al.

As stated, the present invention is neither disclosed in nor obvious from Davitt et al. taken alone, so a combination of Davitt et al. with Taylor et al. would not yield the present invention as Taylor et al. adds nothing regarding the effects of red lead addition to a delay composition. Moreover, Taylor et al. describes the use of carboxymethyl cellulose only with "primary explosives" corresponding to the primer charge or initiating charge 15 of lead azide in the present specification, i.e., the charge that is ignited by the claimed delay composition. Although Taylor et al. states (Col. 1, lines 18-19) that "Primary explosives are used for initiating or delay purposes," it is clear that the only "primary explosives" contemplated by the patent are very different in composition from the mixture of barium sulfate, silicon and red lead to which applicant's claims are limited.

A characteristic of the "primary explosive" compositions with which Taylor et al. is exclusively concerned is that they are formed by precipitation of crystals from solution, wherein "The addition of carboxymethyl cellulose gives very effective control of the rate of burning by regulating the crystal growth as well as the inertness of the explosive" (Col. 3, lines 63-66). Consequently, insofar as Taylor et al. can be said to indicate a relation between the use of carboxymethyl cellulose and burning rate, that relation exists only as to

compositions in which the addition of carboxymethyl cellulose can regulate crystal growth of the primary explosive. Applicant's claimed delay composition of barium sulfate, silicon and red lead is not produced by precipitation of crystals formed in solution; hence the teaching of Taylor et al. could not indicate, to a person of ordinary skill in the art, how carboxymethyl cellulose would affect such combinations.

It follows that Taylor et al. would not suggest or make obvious the asserted combination of carboxymethyl cellulose with a delay composition comprising barium sulfate, silicon and red lead. Reinforcing this conclusion is the statement, in Taylor et al. (Col. 1, lines 28-34) that "The primary explosive art . . . advances slowly as no improvement can be theoretically predicted and even techniques used in the manufacture of other explosives cannot be applied" By a parity of reasoning, such a narrow limit of predictability would negative obviousness in the application of a teaching in the primary explosive art to the very different delay compositions of Applicant's claims.

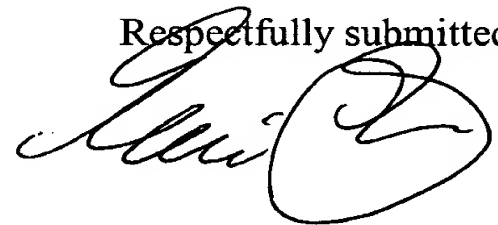
Taylor et al. mentions only carboxymethyl cellulose whereas Applicant's claims 5 and 9 more broadly recite binders. But if Taylor et al. fails to make obvious the use of carboxymethyl cellulose in the specific compositions of Applicant's claims, surely it does not make obvious such use of any other binder in the latter compositions.

In summary, it is believed that the present invention is neither disclosed in nor obvious from Davitt et al. when taken alone, and is certainly not obvious from a combination of Davitt et al. and Taylor for the reasons given.

Favorable reconsideration of the rejection is therefore requested.

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Respectfully submitted,

A handwritten signature in black ink, appearing to read 'Edwin Gale', written over a large, loopy circular flourish.